



# **SBC-VIS and SBC-IR Soleil-Babinet Compensator**

## **User Guide**



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## Chapter 1 Introduction

The Soleil-Babinet Compensator is a continuously variable, zero order retarder (waveplate) which operates over a broad wavelength range. The classical design of the compensator consists of a long birefringent wedge mounted on an adjustable slide. A fixed wedge mounted to a compensator plate completes the optical system. The retardance is adjusted by moving the position of the long wedge relative to the short wedge using a precision digital micrometer. This allows the retardance to vary continuously while maintaining a uniform retardance across the aperture at any given setting (see Chapter 6 for more details).

Thorlabs offers two models: the SBC-VIS and SBC-IR which use quartz optics to cover a spectral range of 365-800 nm and 745-1650 nm respectively.

Our standard Soleil-Babinet Compensators are uncoated for broad spectral operation. To minimize reflection losses when using the compensator over narrow wavelength ranges, AR-coated versions are available upon special request.

Applications include birefringence compensation, precision retardance measurements and high resolution ellipsometry.

Standard features of all the compensator versions include:

- Continuously Variable Retardance
- Uniform Retardance over Full Aperture
- 3 Wavelength Ranges (UV, VIS, IR)
- Digital Micrometer Readout
- Graduated Rotation Ring with Vernier Readout
- 45° Index Stops for Rapid Setup
- Adjustable Kinematic Tilt Adjustment
- Optional RS-232 Interface & Software available

## Chapter 2      Setup

### 2.1.    Unpacking

The compensator is shipped from Thorlabs ready to run. Carefully unpack the compensator and inspect the optics by looking through the aperture. Remove any loose particles of dust by gently blowing a stream of compressed air across the optic. If there are any signs of damage on the optics, contact Thorlabs for an immediate replacement.

### 2.2.    Basic Compensator Operation

The compensator can be thought of as a retardation plate, or waveplate, with an adjustable retardance. Just like a conventional waveplate, the retarder has a fast and slow axis. The fast axis is indicated on the front cover of the optics housing.

The retardance is varied by adjusting the digital micrometer which moves the long wedge inside the compensator. The retardance is controlled by total optical path which is determined by the position of the long wedge relative to the fixed wedge and the compensating optic.

The adjustment range of Thorlabs Soleil Babinet Compensators is a minimum of one full zero wave of retardance over the operating spectral range. Just like quartz waveplates, the retardance of the compensator is wavelength dependent. Fortunately, calibrating the compensator for any given wavelength is relatively simple and is typically done in the field for maximum accuracy (see Section 2.4).

#### 2.2.1.   Digital Micrometer

The graduated rotation dial has laser-engraved markings every 1 degree. The matching index on the compensator body has a Vernier scale to allow for very precise continuous rotational adjustments. A thumbscrew on the side of the compensator body locks the rotating dial in place.

To adjust the rotation, loosen the thumbscrew on the side of the compensator housing, rotate the compensator into position, and then re-tighten the thumbscrew.

#### 2.2.2.   Graduated Rotation Dial

The graduated rotation dial has laser engraved markings every 1 degree. The matching index on the compensator body has a Vernier scale to allow for very precise continuous rotational adjustments. A thumbscrew on the side of the compensator body locks the rotating dial in place.

To adjust the rotation, loosen the thumbscrew on the side of the compensator housing, rotate the compensator into position, and then re-tighten the thumbscrew.

#### 2.2.3.   45° Detent Stops

For many compensator applications, the rotational fine adjustment is set once and the compensator is then rotated in 45° increments (e.g. when calibrating the compensator or measuring an unknown retardance). The Thorlabs compensators include spring loaded detent stops spaced every 45° for this purpose. Simply grab the compensator housing and rotate the compensator to the desired detent position.

Note: if the detent adjustment becomes too tight or too loose, the spring tension may need to be adjusted.

#### 2.2.4.   Kinematic Azimuth/Elevation (Tip/Tilt) Adjustment

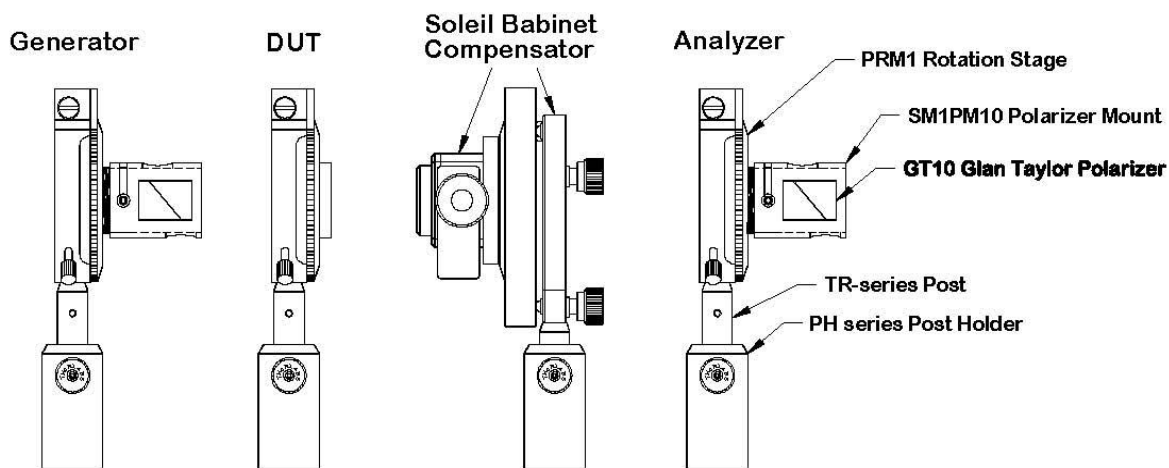
The compensator includes two fine pitch 1/4-80 adjustment screws on the back of the compensator housing to provide adjustment of the azimuth and elevation for precise alignment. This design is based on a proven high-quality kinematic approach used throughout Thorlabs mirror mounts.

### 2.3. Using Compensator with Crossed Polarizers

Many compensator applications require using compensator between a pair of crossed polarizers in a classic generator/analyzer configuration. In such cases, the polarizers are spaced apart with their polarization axis rotated  $90^\circ$  to each other so that no light is transmitted. The compensator is then placed between the two polarizers such as when calibrating the compensator. When using the compensator to measure an unknown retardance, the optic to be tested is also placed between the crossed polarizers along with the compensator.

For best accuracy, high quality calcite polarizers mounted in precision rotation mounts should be used. Also, the device under test should also be mounted in a precision rotation stage so that the optic axis of the device can be precisely aligned.

Thorlabs carries a complete line of high quality calcite polarizers, rotation mounts and other accessories useful for constructing this setup. Figure 1 shows a typical arrangement.



**Figure 1** Typical Arrangement of Compensator with Crossed Polarizers

**Generator** – This stage is the input for the test laser and uses a precision polarizer (e.g. GT10 Glan Taylor calcite polarizer) mounted in a precision rotation stage to generate a very pure linear state of polarization.

**Analyzer** – A second polarizer stage (identical to the generator) is used for the output analyzer. Normally this polarizer is rotated so that its transmission axis is  $90^\circ$  with respect to the analyzer to achieve the crossed condition (minimum light transmission).

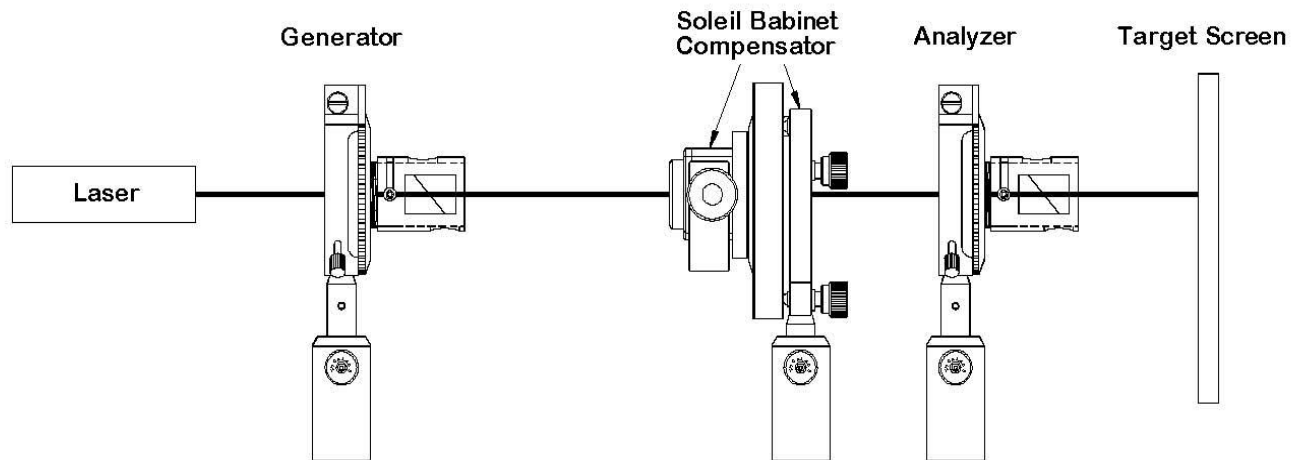
**DUT** – When measuring the retardance of an unknown device (i.e. waveplate), the device under test (DUT) is placed in between the crossed polarizers with its optical axis rotated  $45^\circ$  from the generator polarization axis.

**Soleil Babinet Compensator** – The compensator is placed in between the crossed polarizer, and like the DUT, its optic axis is rotated  $45^\circ$  from the generator polarization axis.

## 2.4. Calibration

Normally, the first step to using a compensator is to calibrate it at the operating wavelength. If this is not possible, it may be necessary to calibrate at a test laser wavelength (i.e. a single mode HeNe) and extrapolate to the operating wavelength. Note: the SBC-COMM Serial Interface and Software package automates most of this process

### 2.4.1. Calibration Procedure



**Figure 2 Setup for Calibration Procedure**

1. Set up the crossed polarizer configuration as shown in Figure 2.
2. With the compensator removed from the setup, rotate the analyzer so that the spot transmitted onto the target screen is minimized. At this point the polarizers are crossed. If the calibration laser is polarized, it may be necessary to first rotate the generator so that the laser is not blocked by the generator.



#### WARNING



**Never look directly into the laser! Project the laser onto a target screen for indirect viewing.**

3. Insert the compensator in between the two polarizers. Adjust the tip/tilt adjustments so that the compensator is perpendicular to the optical beam. This is best done by observing the back reflection from the compensator to the test laser and adjusting the compensator so that the reflected spot is close to the laser output aperture.
4. At this point, there should be some light transmitted onto the projection screen. Loosen the rotation locking thumb screw and rotate the compensator until the transmitted spot is extinguished. Tighten the thumb screw. At this point the fast axis of the polarizer is aligned with one of the transmission axes of the two polarizers.
5. With the rotation dial locked in place, rotate the compensator to the next 45° detent stop. There should be some light transmitted to the target screen unless the compensator happens to be at exactly one full wave of retardance.
6. Adjust the micrometer until the spot is extinguished. This is the first of two null to be used as a full wave reference
7. Press the ZERO/ABS button on the micrometer to reset the display to 00.000.
8. Continue adjusting the micrometer so that the laser spot becomes visible again. Continue adjusting in this direction until the spot extinguishes. This is the second null.

9. Record the micrometer reading at this position. The distance indicated on the micrometer corresponds to the calibration distance equal to one full wave of retardance at the test laser wavelength.

## Chapter 3      Setting the Compensator to a Specific Retardance

### 3.1.      Setting the Compensator at the Calibration Wavelength

The calibration distance can be used to set the compensator to any fractional wave of retardance at the calibration wavelength using the following relationship:

$$\begin{aligned} X_{\text{cal}} &= \text{calibration distance (obtained from 2.4.1)} \\ N &= \text{desired retardance (in waves)} \\ X_{\text{SBC}} &= N * X_{\text{cal}} \quad (\text{Eq. 3.1}) \end{aligned}$$

An example of this equation is provided here:

$$\begin{aligned} \text{Test wavelength} &= 632.8\text{nm} \\ X_{\text{cal}} &= 14.55 \\ N &= 0.25 \text{ (i.e. quarter wave of retardance)} \\ X_{\text{SBC}} &= 14.55 * 0.25 = 3.638 = \text{micrometer setting to get a quarter wave of retardance.} \end{aligned}$$

### 3.2.      Setting the Compensator for other Wavelengths

Sometimes it is not possible or convenient to calibrate the compensator at the operating wavelength. For example; the compensator is to be used in an Nd:YAG system but for logistical reasons can only be calibrated using a low power HeNe.

In such cases, the compensator target position can be extrapolated using the calibration obtained in 2.4.1 together with the basic retardance equations for the compensator. The following equation calculates the compensator position at the target wavelength and retardance:

$$X_{\text{SBC}} = (N_2 * \lambda_2 * B(\lambda_2)) / (\lambda_1 * B(\lambda_1)) * X_{\text{cal}} \quad (\text{Eq 3-2})$$

Where:  $X_{\text{SBC}}$  is the micrometer setting to obtain the desired retardance,  $X_{\text{cal}}$  is the calibration from 2.4.1,  $N_2$  is the desired retardance at wavelength  $\lambda_2$ ,  $\lambda_2$  is the new wavelength, and  $B(\lambda)$  is the birefringence of the SBC model. For models SBC-VIS and SBC-IR, use equation 6-1 in Chapter 6 for  $B(\lambda)$ .



## Chapter 4 Measuring an Unknown Retardance/Birefringence

One of the applications for the Soleil-Babinet Compensator is to measure the retardance of an unknown device. From this the birefringence can easily be calculated as well. To measure the retardance of an unknown sample:

1. Set up the crossed polarizer and DUT mount as shown in figure 1.
2. Verify the input and output polarizers.
3. Insert the compensator and rotate it until the spot is extinguished.
4. Insert the DUT into the rotation mount and insert it into the crossed polarizer setup making sure the DUT is perpendicular to the optical path.
5. Rotate the DUT until the laser spot is extinguished on the projection screen. At this point, the optical axis of the DUT is perpendicular to the optical path.
6. Rotate the DUT to 45°.
7. Rotate the compensator to 45°.
8. Adjust the compensator until the spot is extinguished again and record the micrometer reading at this point as  $X_{SBC}$ .
9. The retardance at the test wavelength can now be calculated using the following equation:

$$N_{DUT} = 1.0 - X_{SBC} / X_{CAL} \quad (\text{eq. 4-1})$$

Where  $N_{DUT}$  is the retardation of the device at the test wavelength,  $X_{SBC}$  is the micrometer reading from Step 8, and  $X_{cal}$  is the calibration from 2.4.1.

To calculate the birefringence from the measured retardance, the thickness of the part must be measured precisely (i.e. using a micrometer or other device):

$$B(\lambda) = N_{DUT} * \lambda / X_{DUT} \quad (\text{eq. 4-2})$$

Where  $N_{DUT}$  is the retardation measured above,  $X_{DUT}$  is the thickness of the DUT in  $\mu\text{m}$ ,  $\lambda$  is the wavelength, and  $N_{DUT}$  is measured in  $\mu\text{m}$ .

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## Chapter 5      Optional LabVIEW Software and Serial Support

Extend the versatility of your compensator by using our SBC-COMM serial interface and compensator software. The software combines an easy to use graphical interface with the performance models for all of our compensators to allow the user to easily and quickly calibrate the compensator and “dial in” the desired retardance at any wavelength.

Also included is a real-time mode, which monitors the compensator position and give instantaneous readouts of the compensator retardance at a user-specified wavelength.

Included are an RS-232 serial interface module, SPC interface cable for the compensator, and a CD with the LabVIEW™ drivers and a stand-alone LabVIEW Runtime Library. The SBC-COMM LabVIEW drivers and Serial Interface Kit is compatible with all versions of the Thorlabs Soleil-Babinet Compensator.

The software was developed in National Instrument's LabVIEW Version 6.0. Also included are the compensator LabVIEW drivers for experienced users who want to adapt the compensator to their own specific needs (you'll need to have a licensed copy of LabVIEW on your system).

The Software and Serial Port Kit Includes:

- CD with Micrometer Software, LabVIEW drivers, and Documentation
- Serial Interface Unit with DB9 Connection
- SDP Data Cable (Attaches Micrometer to Serial Interface Unit)

### 5.1.      Serial Interface Setup

The compensator computer interface must be connected to a standard 9-pin serial port on the PC. If necessary, use a 25-to-9 pin adapter (available at most local PC supply stores).

1. Select the serial port that the compensator will be connected to and note the port number (e.g. COM1, COM2) as this will be needed later when running the software.
2. Unpack the Serial Interface Unit and SDP cables.
3. Attach the mini-DIN side of the SPC cable to the mating connector on the bottom of the compensator micrometer. This is a keyed connector and it may be necessary to rotate the connector to align the pins with the mating sockets.
4. Attach the rectangular end of the SPC cable to the mating connector on the Serial Interface Unit. This is also a keyed connector and can only be plugged in one way.
5. Attach the DB9 serial cable to the PC and note which port this is for later use.

### 5.2.      Software Installation

Please refer to the README.TXT file on the CD for specific installation instructions.

#### 5.2.1.   Stand-Alone Version

The software consists of a stand-alone version, which does not require any programming skill to operate. The stand-alone version requires that the LabVIEW runtime engine (included on the CD) be installed on the target PC in order to operate.

### **5.2.2. LabVIEW Drivers**

A LabVIEW .vi file is also included for users familiar with LabVIEW programming and who would like to modify the compensator software. This requires a licensed version of LabVIEW Version 6.i or higher (not included) in order to run.

## **5.3. Software Operation**

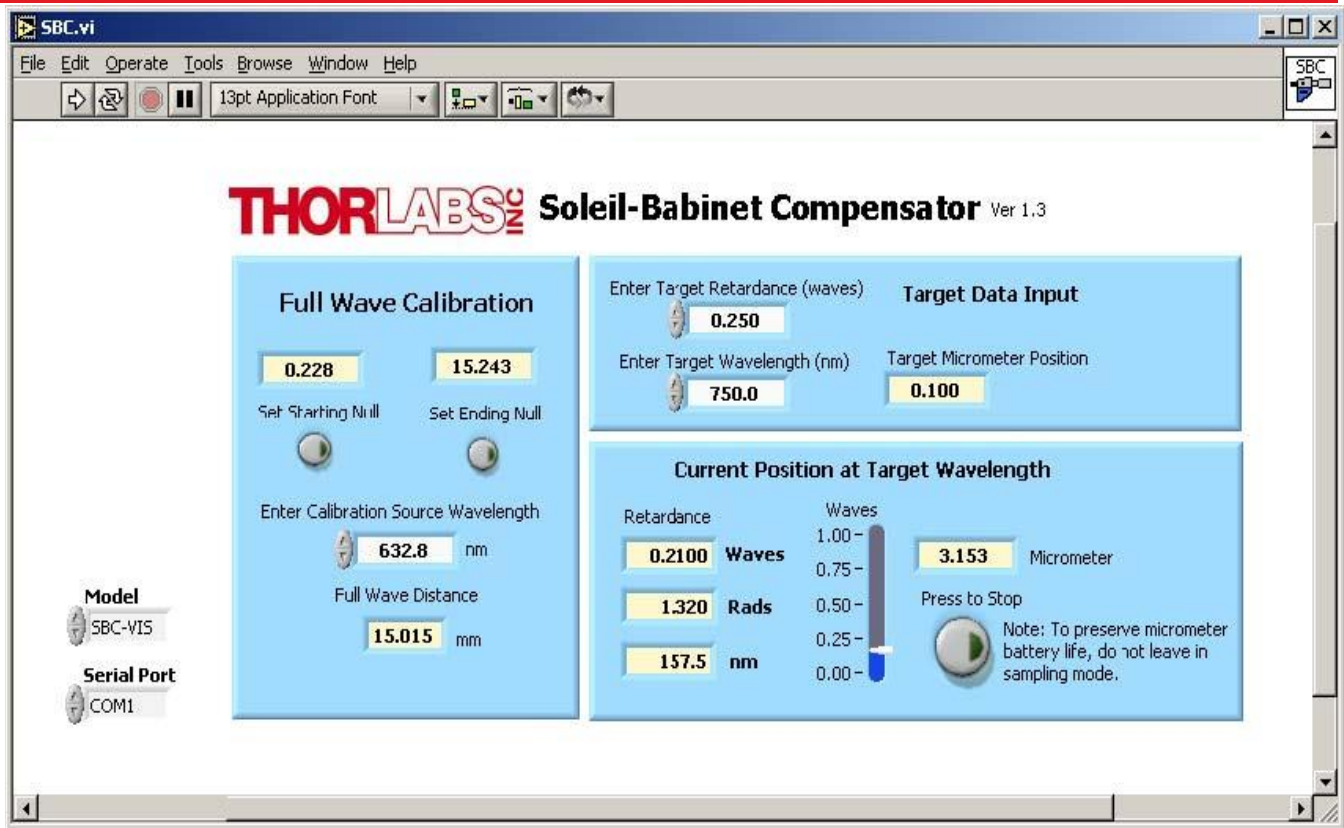
### **5.3.1. Overview**

The operational RS-232 interface and LabVIEW drivers extend the versatility of the Soleil-Babinet Compensator by allowing automated measurements, easy wavelength conversion, and the ability to talk to the compensator from a remote LabVIEW program.

A serial interface on the micrometer, referred to as an SPC port by the micrometer manufacturer, allows the position of the micrometer to be read remotely by a LabVIEW program. Using this interface, we've developed a LabVIEW program that automates much of the manual calculations that are typically needed. For instance, with two simple clicks of the mouse button, the compensator can be completely calibrated at the test wavelength.

We've embedded the wavelength-dependent birefringent data for all versions of the compensator into the software to allow for extrapolation of the retardance into any wavelength across the operating range. This allows the compensator to be calibrated with a common lab laser (e.g. a HeNe). The software is then used to calculate the precise position the micrometer must be adjusted in order to obtain the desired retardance at the target wavelength.

Included on the CD is a stand-alone version (for users who do not own LabVIEW), as well as the LabVIEW .vi files for those who wish to experiment and customize the program.



**Figure 3** Soleil-Babinet Compensator User Interface Screen

### 5.3.2. User Interface Fields

The fields on the user interface screen have two different background colors to distinguish the field type:

- Fields with a white background are user input fields which require input from the user.
- Yellow background fields are calculated fields and cannot be modified by the user.

#### General Parameters

**Model (user input):** Select the model compensator to be used with the software. Options are SBC-VIS or SBC-IR.

**Serial Port (user input):** Select the serial port where the compensator is attached to the PC. Options are COM1, COM2, COM3, and COM4.

#### Full Wave Calibration

**Set Starting Null (button and display):** During calibration, the first null is found by manually adjusting the retardance using the micrometer. Once the null is found, this button is pushed by the user and the software records this position and displays it in the text box.

**Set Ending Null (button and display):** During calibration, the micrometer is manually adjusted until the second null is found (to transverse one full wave of retardance). Once the null is found, this button is pushed by the user and the software records this position and displays it in the text box.

**Enter Calibration Source Wavelength (user input):** The wavelength of the calibration laser is entered here. This value is used to complete the full wave calibration.

**Full Wave Distance (calculated field):** The software calculates the full wave distance in micrometer units as the difference between the starting and ending nulls and displays the result here.

#### **Target Data Input**

**Enter Target Retardance (waves) (user input):** Enter the desired retardance to set the compensator.

**Enter Target Wavelength (nm) (user input):** Enter the wavelength at which the compensator will be used.

**Target Micrometer Position (Calculated Field):** The software calculates the micrometer position at which the compensator must be set by the user in order to get the Target Retardance at the Target Wavelength.

#### **Current Position at Target Wavelength**

**Retardance (calculated field):** As the micrometer is adjusted, the software reads the current position and calculates the retardance at the target wavelength and displays it in three formats: waves, radians, and nm. These fields are updated continuously once the Start button is pressed.

**Waves (calculated bar graph):** A bar graph displays the retardance in graphical format. The graph is updated continuously once the Start button is pressed.

**Micrometer (display only):** The current micrometer position is displayed continuously once the Start button is pressed.

**Press to Start/Stop (button):** Once the compensator has been calibrated, the software can begin polling the micrometer and display the updated retardance fields continuously by pressing this button.

#### **NOTE**

**The micrometer serial interface is powered by the lithium battery inside the micrometer. Leaving the software in continuously polling mode will eventually drain this battery. In order to preserve battery life, the polling should be stopped when the unit is not in use.**

### **5.3.3. Stand-Alone Version**

After installation, the software is ready to run as a stand-alone program. During the installation process, the LabVIEW Runtime Engine, a freely distributable program that is required to run the stand-alone version, is installed. The installation will create a selection in the Start Menu-Programs called SBC. When this is selected, the software will begin loading all necessary modules and present the screen in figure 3.

#### **Running the Software**

1. Select the correct COM port in the lower left corner of the screen. When ready, press the START button.
2. Select the correct compensator model.

After a brief appearance of a banner screen, the User interface Screen as shown in figure 3 will be displayed. At this point, the software is running and should respond to button presses.

If the software is not responding, check the COM port and if necessary, quit the program and restart it using the correct COM port.

### 5.3.4. Calibrating the Compensator

In order to calibrate the compensator, you will need two linear polarizers mounted in rotation stages and a calibration laser. Usually a HeNe laser is used as the calibration laser but other lasers could be used as long as the spectral linewidth is not too large.

Although this procedure looks complex, after performing it once or twice you will become familiar with it to the point that calibrations will be quick and easy.

Thorlabs carries a complete line of polarizers, optic mounts, rotation stages, and other accessories. Please visit our website, [www.thorlabs.com](http://www.thorlabs.com), or contact technical support using the information at the end of this manual for more information.

1. Set the polarizers, compensator, and test laser as shown in figure 2.
2. With the compensator removed from the setup, rotate one of the two waveplates until the two polarizers are exactly crossed at  $90^\circ$ . It helps to place a target screen after the last polarizer so that the transmitted beam can be safely observed. The polarizers are crossed when this beam vanishes.
3. Re-insert the compensator back into the setup. The beam will reappear since the compensator will introduce an arbitrary elliptical polarization which is not extinguished completely by the second polarizer.
4. Loosen the rotation lock screw and rotate the compensator until the beam disappears again. At this point, the fast axis is aligned with the transmission axis of one of the two polarizers. Tighten the lock screw.
5. Check the tip and tilt adjustment by observing the reflected beam and adjust the kinematic adjustment screws on the back plate until the compensator is perpendicular to the beam propagation. If necessary, repeat step 4 to ensure the fast axis is still in alignment with the polarizer.
6. The compensator must now be rotated so that the fast axis is  $45^\circ$  to the linear polarizer. The compensator has spring-loaded detent stops that allow the compensator to be easily positioned. Firmly grasp the compensator optics housing and rotate the compensator to  $45^\circ$ . If the compensator does not move readily, the detent spring tension screw may need to be loosened first. At this point, the compensator is aligned and ready for calibration.
7. Adjust the micrometer clockwise and find the starting Null point. This is the first micrometer position closest to 0.0000 that the beam extinguishes. At this point the retardance is exactly zero waves.
8. Press the Set Starting Null button to capture this location. The screen will update the text box above the button with the current micrometer value. Optional: If you prefer, you can press the ZERO button on the micrometer to set this position to 0.0000, however, this is not necessary since the software will do the necessary calculations.
9. Adjust the micrometer counterclockwise to find the second null. At this point, the retardance is exactly one wave.
10. Press the Set Ending Null button to capture this location. At this point, the software calculates the distance of one full wave of retardance.



#### WARNING



**Do not null the micrometer display from this point on. Doing so will invalidate the calibration and you will need to repeat this procedure.**

11. If you haven't done so already, enter the wavelength of the calibration laser in the "Enter Calibration Source Wavelength" input box. This can be done either before or after the above steps.

At this point, the compensator is accurately calibrated and ready to be used.

### 5.3.5. Setting the Compensator to a Target Retardance

Once the compensator is calibrated, the software will allow you to easily set the compensator to any fractional retardance within the operating spectral range of the unit.

1. Enter the desired retardance in the “Enter Target Retardance” field. The units are in waves.
2. Enter the wavelength at which the target retardance is to be set in the “Enter Target Wavelength” field. This is necessary since the retardance is a function of wavelength for birefringent materials.
3. The software will automatically calculate the position that the micrometer needs to be adjusted to obtain the target retardance and display it in the “Target Micrometer Position” field. The user must manually adjust the compensator to this position.
4. At this point, you can turn on the automatic polling mode by pressing the “Press to Start” button. The software will continuously poll the micrometer and update the values in the retardance display and bar graph. Be sure to press the “Stop” button when finished to preserve the micrometer battery life.

### 5.3.6. Quitting the Stand-Alone Version

To exit the software, select the file option from the File pull down menu. This will completely shut down the software modules.

If you click on the “X” Close Window button, you will need to shut down all of the individual windows that are loaded with the SBC software as well.

### 5.3.7. Running the Compensator Software with LabVIEW

Running the software within LabVIEW is identical to the stand-alone version. Make sure all of the following modules are available for loading:

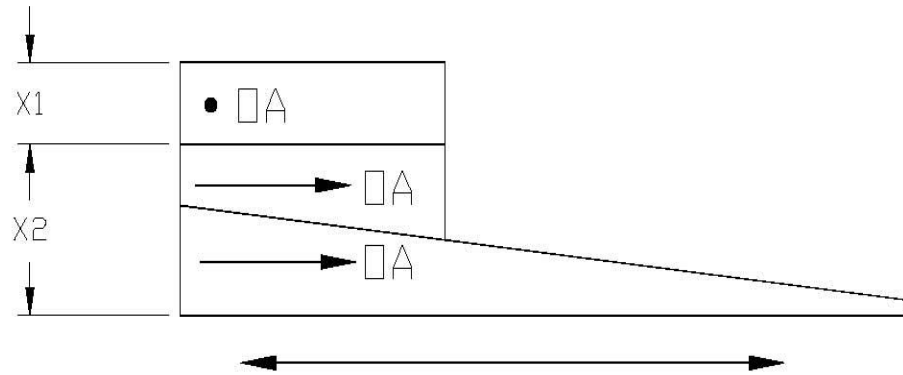
- sbc.vi
- b-quartz.vi
- b-mgf2.vi
- readmic.vi

## Chapter 6 Theory of Operation

The classic Soleil-Babinet Compensator design is based on two birefringent wedges with their optic axis aligned lengthwise and a compensator plate with its optic axis rotated 90° from the wedges. The retardance through the total optical path is:

$$N_{SBC} = B(\lambda) \cdot (X_2 - X_1) / \lambda$$

As seen in figure 4, the distance  $X_1$  is fixed. However, by sliding the long wedge along the direction as shown, distance  $X_2$  can be varied continuously, thereby changing the retardance continuously as well. Since the wedge angle for the fixed and the moving wedge are the same, the optical path length  $X_2$  is uniform across the aperture. This is a unique feature of Soleil-Babinet Compensators.



**Figure 4** Diagram of Wedges Inside the Soleil-Babinet Compensator

As can be seen in the basic compensator equation above, the retardance of the compensator is a function of the birefringence, which is wavelength dependent. The birefringence can be calculated from the Sellmeier equations:

### Equation 6-1: Quartz Sellmeier and Birefringence

$$n_e(\lambda) := \sqrt{1.28851804 + \frac{1.09509924\lambda^2}{\lambda^2 - 1.0210186410^{-2}} + \frac{1.15662475\lambda^2}{\lambda^2 - 100}}$$

$$n_o(\lambda) := \sqrt{1.28604141 + \frac{1.07044083\lambda^2}{\lambda^2 - 1.0058599710^{-2}} + \frac{1.10202242\lambda^2}{\lambda^2 - 100}}$$

$$B(\lambda) := n_e(\lambda) - n_o(\lambda)$$

Note the wavelength is in  $\mu\text{m}$ .



**Equation 6-2:  $\text{MgF}_2$  Sellmeier and Birefringence**

$$n_{\text{omgf2}}(\lambda) := \sqrt{1 + \frac{.487551072\lambda^2}{\lambda^2 - 0.04338408^2} + \frac{0.39875034\lambda^2}{\lambda^2 - .09461442^2} + \frac{2.312035347\lambda^2}{\lambda^2 - 23.793604^2}}$$

$$n_{\text{emgf2}}(\lambda) := \sqrt{1 + \frac{.41344023\lambda^2}{\lambda^2 - .03684262^2} + \frac{.50497499\lambda^2}{\lambda^2 - .09076162^2} + \frac{2.4904862\lambda^2}{\lambda^2 - 23.77199519^2}}$$

$$B_m(\lambda) := n_{\text{emgf2}}(\lambda) - n_{\text{omgf2}}(\lambda)$$

Note: the wavelength is in  $\mu\text{m}$ .

## Chapter 7      Cleaning and Maintenance

Under normal operating conditions, the compensator requires very little maintenance. Most problems can be traced to either a dead battery or dirty optics. Follow the guidelines below if needed.

### 7.1.    Cleaning the Optics

Most of the time, simply blowing dust or debris off the input aperture with a gentle breeze of compressed air is all that is needed. If the input window needs further cleaning, use an optics wipe with propanol or acetone and lightly wipe the optics surface.

Using excessive amounts of acetone may soften the optics mounting adhesive and cause the optics to become loose.



#### WARNING



**Taking the compensator housing apart may disturb the optical alignment and is not recommended. Contact Thorlabs if service is needed.**

### 7.2.    Cleaning the Compensator Housing

The housing can be wiped clean with a lint-free cloth wetted with propanol or a commercial window cleaner. Do not soak the housing—it is not watertight and any moisture introduced inside the compensator may cause condensation problems.

### 7.3.    Micrometer Battery Replacement

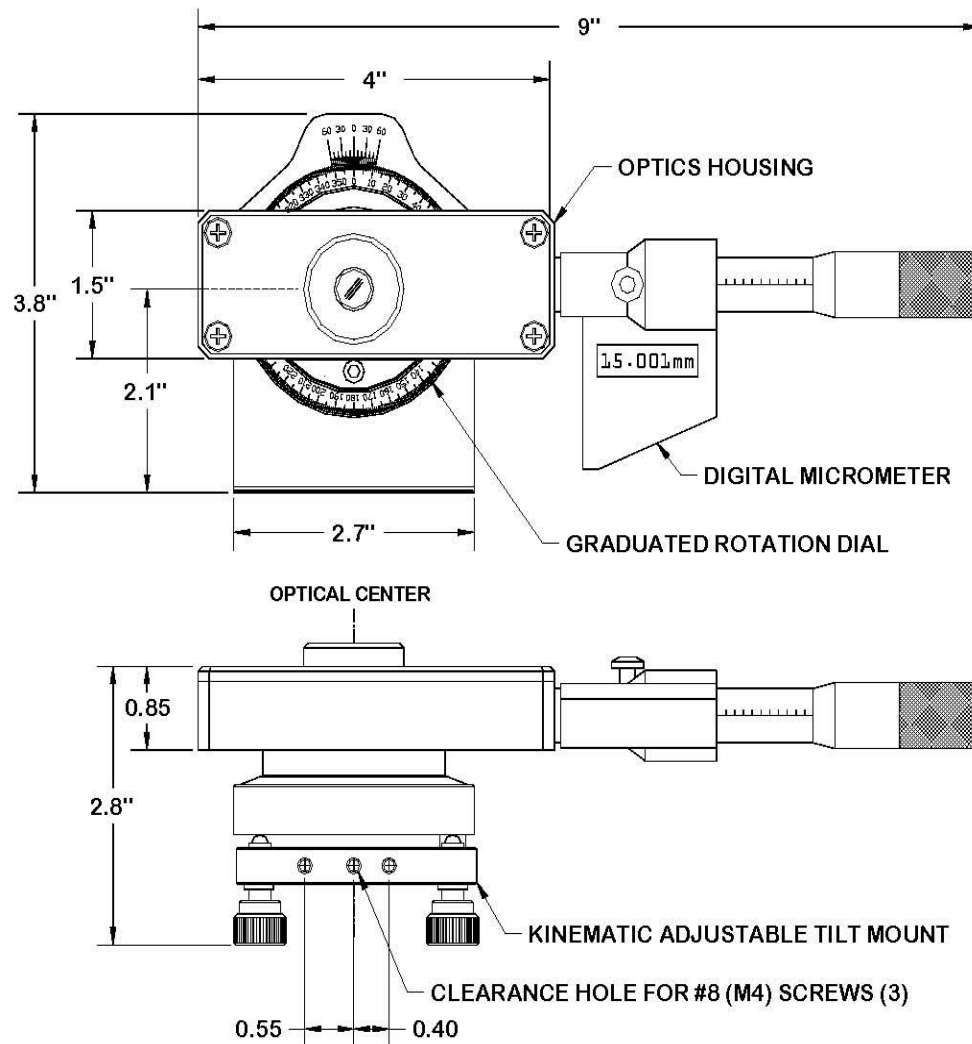
The micrometer uses a 1.5 V type SR44 miniature battery. If the micrometer display goes dim or does not come up at all, it is time to replace the battery. The battery compartment is located on the back of the micrometer. Using the tool provided with the micrometer, a large bladed screwdriver, or a coin, unscrew the battery cover, remove the old battery, and replace with a fresh one. Discard the old battery properly.

If the micrometer display does not come up after replacing the battery, contact Thorlabs for assistance.

## Chapter 8 Specifications

Item #	SBC-VIS	SBC-IR
Wavelength Range	365 to 800 nm	740 to 1650 nm
Retardance Adjustment	0 - $2\pi$ (Full Wave)	
Clear Aperture	$\varnothing 10$ mm	
Beam Deviation	< 1 arcminute	
Transmitted Wavefront Error	< $\lambda/4$	
Surface Quality	40-20 scratch-dig	
Digital Readout Resolution	0.001 mm	
Rotation	360° Continuous	
Rotation Division Scale	1° increments	
Detent Index Stops	Every 45°	

## Chapter 9 Mechanical Drawing



## Chapter 10 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



**Wheelie Bin Logo**

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

### 10.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### 10.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

## Chapter 11 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at [www.thorlabs.com/contact](http://www.thorlabs.com/contact) for our most up-to-date contact information.



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